

Amendments to the Claims

1. (Currently Amended) A commercially mass-produced, integrated circuit (IC) having multiple active circuit components, comprising:

a solid substrate of one conductivity type;

a solid material pocket of a different conductivity type having a side surface and positioned on a selected top surface of said substrate;

a signal-translating, electronic rectifying barrier located between said solid material pocket and the selected top surface of said substrate; and

a solid state material region directly contacting adjoining said solid substrate, said electronic rectifying barrier, and the side surface of said solid material pocket and, together with said electronic rectifying barrier, electrically isolating a selected active circuit element from another neighboring active circuit component to make these two active circuit elements electrically independently operable;

said solid state material region having a depth accuracy of better than 0.13 microns and

~~said solid state material region~~ being continuously and perfectly bonded metallurgically to all said solid substrate, said solid material pocket, and said electronic rectifying barrier, without ~~the almost always present~~ thermally and electrically insulating voids and microcracks visible at 1,000 times magnification in interfacial bonding regions between the bonded device components.

2. (Canceled)

3. (Currently Amended) A mass-produced integrated circuit

as in claim 1 in which ~~a lateral edge of at least one of said solid substrate, said solid material pocket, and said electronic rectifying barrier~~ has a specified vertical thickness ~~lateral dimension having an accuracy of or better~~ less than a few hundred atomic layers.

4. (Canceled)

5. (Previously Presented) A mass-produced integrated circuit as in claim 1 in which a selected significant portion of a major surface of at least one of said solid material pocket, said selected top surface of said substrate, said solid state material region, and said electronic rectifying barrier gradually changes a vertical thickness thereof with closeness in a lateral direction to a lateral edge of said electronic rectifying barrier.

6. (Previously Presented) A mass-produced integrated circuit as in claim 1 in which a selected significant portion of at least one of said solid material pocket, said selected top surface of said solid substrate, said solid state material region, and said electronic rectifying barrier monotonically changes a vertical thickness thereof with closeness in a lateral direction to a lateral edge of said electronic rectifying barrier.

7. (Canceled)

8. (Previously Presented) A mass-produced integrated circuit as in claim 1 in which at least a major surface of one of said electronic rectifying barrier and said solid material pocket is curved.

9. (Canceled)

10. (Previously Presented) A mass-produced integrated circuit as in claim 1 in which the side surface of said solid material pocket is curved over a major portion thereof.

11. (Canceled)

12. (Canceled)

13. (Canceled)

14. (Canceled)

15. (Previously Presented) A mass-produced integrated circuit as in claim 1 in which at least one of top and bottom major surfaces of said electronic rectifying barrier is curved.

16. (Previously Presented) A mass-produced integrated circuit as in claim 1 in which a selected portion of said electronic rectifying barrier has a vertical thickness which gradually increases with closeness in a lateral direction to a lateral edge of said electronic rectifying barrier.

17. (Canceled)

18. (Previously Presented) A mass-produced integrated circuit as in claim 1 in which said electronic rectifying barrier is thin and has a laterally-extending dimension of less than one micron.

19. (Currently Amended) A mass-produced integrated circuit as in claim 1 in which:

said solid state material region consists essentially of a solid material selected from the group consisting of oxide, glass, organics, semiconductor, non-semiconductor, intrinsic semiconductor, a solid comprising metal, intermetallics, organics, ~~semiconductor, a dielectrics~~ dielectric material, and an electrically insulating solid;

said electronic rectifying barrier is selected from the group consisting of a PN junction, a heterojunction, a metal-oxide junction, and a Schottky barrier; and

said solid material pocket is of a semiconductor material selected from the group consisting of Ge, Si, GaAs, GaP, InP, InSb, other III-V semiconductor compounds, other II-VI semiconductor compounds, and mixture thereof.

20. (Currently Amended) A commercially mass-produced, miniaturized integrated-circuit semiconductor device containing multiple transistors therein, comprising:

a first semiconductor material body having a first polarity;

a second semiconductor material body located generally vertically underneath said first semiconductor material body and having a second polarity that is opposite the first polarity;

a signal-translating, electronic rectifying barrier ~~formed between~~ adjoining said first and second semiconductor material bodies; and

a third solid state material body having an electrical conductivity at least one orders of magnitude different from those of said first and second semiconductor material bodies;

~~said third solid state material body~~ and directly contacting respective portions of each of said first and second

semiconductor material bodies and said electronic rectifying barrier, and, together with said electronic rectifying barrier, electrically isolating a selected transistor in said semiconductor device from another neighboring transistor in the same semiconductor device thereby making these two transistors electrically independently operable;

said third solid state material body ~~and~~ having two differentially surface-expanded sides that are not parallel to each other to thereby form on said third solid state material body ~~the device~~ a bottom terminal portion of no more than a micron in ~~having a thickness~~ in a selected direction; and

said thickness being accurate to within of having an accuracy of or better than a few hundred atomic layers.

21. (Canceled)

22. (Previously Presented) A semiconductor device as in claim 20 in which at least one of said first semiconductor material body, said second semiconductor material body, and said third solid state material body is of an intrinsic semiconductor material.

23. (Currently Amended) A semiconductor device as in claim 20 in which said third solid state material body has an as-formed metallurgically graded-seal continuity ~~of a graded-seal type~~ with respect to at least one of said first and second semiconductor material bodies; and said first semiconductor material body has a vertical thickness of less than a few hundred atomic layers.

24. (Previously Presented) A semiconductor device as in claim 20 in which the terminal portion of said third solid state

material body is vertically within less than a distance from a selected point inside said electronic rectifying barrier;

said distance being selected from the group consisting of one micron and 0.1 microns.

25. (Previously Presented) A semiconductor device as in claim 20 in which said third solid state material body has a geometry, position, and orientation relative to said first and second semiconductor material bodies, to allow adequate stress and strain modification on said electronic rectifying barrier thereby improving device performance.

26. (Previously Presented) A semiconductor device as in claim 25 in which said third solid state material body is favorably stressed, and has a blunt and rounded bottom of zero width so that lateral mismatch stresses at the bottom in the zero width direction is also zero, and

in which the rounded bottom of said third solid state material body is located within a specified distance from a designated point inside said electronic rectifying barrier to achieve a beneficial proximity effect;

said specified distance being selected from the group consisting of one micron and 0.1 microns.

27. (Canceled)

28. (Currently Amended) A semiconductor device as in claim 20 in which said third solid state material body is of an electrically insulating material selected from the group consisting of an oxide, a nitride, organics, semiconductor, a solid comprising metal, intermetallics, a dielectric material, intrinsic semiconductor, other insulator, or a mixture thereof.

29. (Canceled)

30. (Currently Amended) A semiconductor device as in claim 20 in which said third solid state material body has a designed, three-dimensionally controlled shape, size, vertical dimension and location accurate to fractional microns.

31. (Currently Amended) A semiconductor device as in claim 20 in which said third solid state material body has a rounded bottom portion forming an inverted arch making the device more mechanically stable and reliable.

32. (Previously Presented) A semiconductor device as in claim 20 in which the terminal portion of said third solid state material body is less than 1 micron wide in a selected direction.

33. (Previously Presented) A semiconductor device as in claim 20 in which said electronic rectifying barrier has a curved major surface.

34. (Previously Presented) A semiconductor device as in claim 20 in which said third solid state material body has a cylindrical surface.

35. (Canceled)

36. (Previously Presented) A semiconductor device as in claim 20 in which said electronic rectifying barrier is stressed to improve a performance of said semiconductor device.

37. (Canceled)

38. (Currently amended) A semiconductor device as in claim 20 in which:

said third solid state material body consists essentially of a material selected from the group consisting of a solid, an electrically insulating solid, oxide, glass, organics, semiconductor, non-semiconductor, a solid comprising metal, intermetallics, a dialectical material, intrinsic semiconductor, and a mixture thereof;

said electronic rectifying barrier is selected from the group consisting of a PN junction, PI junction, NI junction, metal-oxide, oxide-semiconductor, interfacial rectifying barrier, ~~and~~ heterojunction, ~~and~~ other optoelectromagnetically active signal-translating region, a Schottky barrier; and a mixture thereof;

said first semiconductor material body is of a semiconductor material selected from the group consisting of Ge, Si, GaAs, GaP, InP, InSb, other III-V semiconductor compounds, other II-VI semiconductor compounds, and mixture thereof.

39. (Canceled)

40. (Canceled)

41. (Canceled)

42. (Canceled)

43. (Canceled)

44. (Canceled)

45. (Currently Amended) An integrated circuit as in claim 1 in which said electronic rectifying barrier adjoins both said solid substrate and said solid state material region at a place where a periphery of said electronic rectifying barrier is differentially surface-expanded vertically to passivate the adjoining rectifying barrier and to reduce noise, instability, leakage current, electrical shorts, and failure due to low breakdown voltage.

46. (Previously Presented) An integrated circuit as in claim 1 in which said solid state material region is a vertically elongated region of less than 1 micron in width or size with an accuracy of less than 0.13 microns, and having a bottom of a shape selected from the group consisting of flat, rounded, cylindrical, hemispherical, and conical or V-shaped.

47. (Currently Amended) An integrated circuit as in claim 1 including means for circulating a rapidly moving cooling fluid in a microscopic vicinity of said signal_ translating, electronic rectifying barrier to achieve surface cooling of said electronic rectifying barrier.

48. (Currently Amended) An integrated circuit as in claim 1 in which said electronic rectifying barrier has a lateral edge, and at least one of said solid material pocket, said electronic rectifying barrier, and said solid state material region has a portion thereof which gradually and continuously changes its vertical thickness with closeness to ~~said~~ a lateral edge of said electronic rectifying barrier.

49. (Currently Amended) An integrated circuit as in claim 1 in which at least one of said solid material pocket, said

rectifying barrier, and said solid state material region has a selected portion thereof which gradually and monotonically changes its vertical thickness with closeness to ~~said~~ a lateral edge of said electronic rectifying barrier.

50. (Previously Presented) An integrated circuit as in claim 1 in which a selected portion of at least one of a major surface of said solid material pocket, said electronic rectifying barrier, and said solid state material region is curved.

51. (Canceled)

52. (Currently Amended) An integrated circuit as in claim 1 in which said solid state material region is an elongated deep and narrow, solid state material region; and including:

a second elongated deep and narrow, solid state material region microscopically close to said elongated deep and narrow, solid state material region;

each of said two elongated, deep and narrow, solid state material regions ~~region and said second elongated deep and narrow, solid state material region~~ being within a micron of both said solid substrate and said electronic rectifying barrier;

said second elongated, solid state material region ~~also~~ having a ~~second~~ submicron width or size at a ~~second~~ terminal portion thereof where it is closest to said electronic rectifying barrier; and

both said elongated, solid state material regions ~~region and said second elongated, solid state material region~~ having aspect ratios exceeding 3, being oriented normally of a common major bottom surface of said solid substrate, and extending downward from a common top major surface of said solid material

pocket whereby said two elongated, solid state material regions ~~region and said second elongated, solid state material region~~ are parallel to each other.

53. (Currently Amended) An integrated circuit A ~~semiconductor device~~ as in claim 52 in which said two elongated, solid state material regions ~~region and said second elongated, solid state material region~~ have different lengths so that these two solid state material regions reach different depths inside said solid substrate.

54. (Currently Amended) An integrated circuit A ~~semiconductor device~~ as in claim 52 in which said two elongated, solid state material regions ~~region and said second elongated, solid state material region~~ differ in electrical conductivity by at least one order of magnitude from that of the material of said semiconductor material pocket.

55. (Canceled)

56. (Currently Amended) An integrated circuit as in claim 1 in which:

materials ~~material~~ of said two solid material pockets ~~pocket~~ and said solid state material regions ~~region~~ are solids which are 100% dense, substantially chemically pure and uniform, and non-contaminating, and impervious to contaminating gases;

at least one of said two solid state material regions ~~region~~ is stressed to favorably affect a device performance, and has a rounded bottom of zero width so that lateral mismatch stresses at the bottom in the zero width direction is also zero,

said electronic rectifying barrier is located within a specified distance, with a fractional micron accuracy, from a

designated point inside said electronic rectifying barrier to achieve a beneficial proximity effect; and

said specified distance being selected from the group consisting of one micron and 0.1 microns.

57. (Currently Amended) A mass-produced, low-cost miniaturized solid state, integrated circuit device containing multiple transistors, comprising:

a first solid state material of a first conductivity type;
a second solid state material of a second conductivity type positioned under the first solid state material, the first and second solid state materials having respective adjoining portions;

a signal-translating, rectifying barrier region lying between and directly contacting the respective adjoining portions; and

a device material region starting at least in the first solid state material and extending toward the rectifying barrier region to form a lower bottom which is within a micron ~~of~~ below a selected point inside the rectifying barrier region to thereby combine with said rectifying barrier region for electrically isolating a selected transistor from another neighboring transistor;

a major portion of a top surface area of device chip being occupied by said multiple transistors ~~circuit elements~~ themselves and not by inert or inactive device material regions thereby achieving radically improved, device miniaturization.

58. (Currently amended) A mass-produced, solid state integrated circuit device as in claim 57 in which the rectifying barrier region is selected from the group consisting of PN junction, metal-semiconductor or Schottky barriers,

heterojunction, metal-oxide, other electrically rectifying barriers, and a mixture thereof;

at least one of the first and second solid state materials is selected from the group consisting of Si, Ge, GaAs, GaP, InP, InSb, intrinsic semiconductor, III-V semiconducting compound, II-VI semiconducting compound, and a mixture thereof;

the device material region penetrates downward through the rectifying barrier region to reach the second solid state material and, in combination with the rectifying barrier region; electrically isolates said multiple transistors ~~device~~ ~~components~~ from one another; and

a bottom of the device material region is less than 0.1 microns and close to zero microns below the rectifying barrier region.

59. (Currently amended) A mass-produced, solid state integrated circuit device as in claim 57 in which the device material region has a bottom which is closer to zero microns than 0.1 microns below the rectifying barrier region.

60. (Currently Amended) A mass-produced, solid state integrated circuit device as in claim 57 in which the device material region is an elongated device material region; is accurate to less than a micron in a dimension selected from the group consisting of shape, size, depth, and chemical composition profiling; and consists essentially of a device material selected from the group consisting essentially of air, a gas, oxide, nitride, glass, organics, semiconductor, non-semiconductor, a solid comprising metal, intermetallics, dialectical material, other electrically insulating material, and a mixture thereof.

61. (Currently Amended) A mass-produced, solid state integrated circuit device as in claim 60 in which a bottom of the elongated device material region is close to zero microns below the rectifying barrier region..

62. (Currently Amended) A mass-produced, solid state integrated circuit device as in claim 60 in which the elongated, device material region has an intentionally designed and produced rounded bottom having a vertically curved peripheral surface thereat;

the rectifying barrier region adjoining the rounded bottom of the elongated device material region and having a matching curved peripheral surface thereon thereby passivating and differentially expanding greatly the curved peripheral surface of the rectifying barrier region for protection against Type I contaminants, for eliminating wasteful central flat portions at bottoms of similar device material regions in prior art devices, for reducing mismatch thermal stresses leading to electrical device failures, for minimizing electrical field gradient across a surface-passivated and expanded, rectifying barrier region, and for improving mechanical and electrical device yields and reliabilities.

63. (Currently Amended) A mass-produced, solid state integrated circuit device as in claim 57 in which only a minor portion of a top surface area of device chip is not occupied by said multiple transistors ~~device circuit elements~~ themselves;

said multiple transistors ~~device circuit elements~~ having no centrally large and flat bottoms as in oxidized isolation bottoms of Peltzer and Murphy devices, thereby achieving radically improved device miniaturization.

64. (Currently Amended) A mass-produced, solid state integrated circuit device as in claim 57 in which the first solid state material is purposely broken up into a plurality of smaller material patches so that mismatch stresses from varying coefficients of material thermal expansions are reduced in proportion to the smaller size of the broken material patches thereby improving device performance.

65. (Currently Amended) A mass-produced, solid state integrated circuit device as in claim 57 in which the device material region is an elongated, cylindrical device material groove having ~~both~~ an aspect ratio of over 3 to 5 ~~and a cylindrical radius of less than one micron,~~ and is oriented generally normally of a top major surface of the second solid state material.

66. (Currently Amended) A mass-produced, solid state integrated circuit device as in claim 65 in which the elongated, cylindrical device material groove is purposely tilted relative to a top ~~atop~~ surface of the second solid state material so that the device material groove is above a bottom plane of the rectifying barrier region at some places where the groove depth is less than zero (or $h < 0$), substantially coincides with the same bottom plane of the rectifying barrier region at another place where the groove depth is zero (i.e., $h = 0$), but lies below the same bottom plane of the rectifying barrier region at other places where the growth depth is greater than zero (or $h > 0$).

67. (Currently Amended) A mass-produced, solid state integrated circuit device as in claim 65 in which the elongated, cylindrical device material groove has a cylindrical radius of less than one micron.

68. (Currently Amended) A mass-produced, solid state integrated circuit device as in claim 65 including at least one additional, elongated, cylindrical device material groove oriented normally of a top major surface of the second solid state material, and microscopically close to the other elongated, cylindrical device material groove;

both the two device material grooves having sizes of less than two microns and different lengths to thereby extend vertically downward from a common higher, vertical level to different depths into the second solid state material.

69. (Currently Amended) A mass-produced, solid state integrated circuit device as in claim 65 in which a bottom of the elongated cylindrical device material groove has ~~is above the rectifying barrier region so as to have~~ a groove depth of less than 0.1 microns but microscopically close to zero microns and designed specifically for at least one of thermal, magnetic, and electrical contacting or for optical communication to the device, without actual physical exposure to ambient of the second solid state material.

70. (Currently Amended) A mass-produced, solid state integrated circuit device as in claim 65 in which the elongated, cylindrical device material groove is real-time ~~feed-back~~ automation controlled to submicron accuracy in a depth to as close to zero microns below the rectifying barrier region as possible, yet still to have a meaningful device yield to be commercially viable because of the submicron depth accuracy.

71. (Currently Amended) A mass-produced, solid state integrated circuit device as in claim 65 in which the elongated,

cylindrical device material groove has said a rounded bottom; and

the rectifying barrier region adjoins a rounded bottom of the device material groove at a curved peripheral surface thereof, thereby vertically maximizing the peripheral surface expansion and minimizing electrical field gradient across the rectifying barrier region to improve device yield and manufacturability.

72. (Currently Amended) A mass-produced, solid state integrated circuit ~~(Previously Presented) A mass-produced, solid-state~~ device as in claim 57 in which the device material region is an elongated groove having a microscopically precise groove bottom surface suitable for introducing a precise amount and shape of a foreign matter through the newly formed, highly precise groove bottom surface, thereby achieving microscopically precise three-dimensional control as to shape, size, and position of a region of the foreign matter introduction into the device.

73. (Currently Amended) A mass-produced, solid state integrated circuit device as in claim 57 in which the device material region is a vertical and electrically insulating, elongated device material groove; and

a lower end of the vertical, elongated groove has a centrally rounded bottom of substantially zero width in a direction parallel to a top major surface of the second solid state material whereby mismatch stresses ~~in the direction~~ arising from varying coefficients of thermal expansions of different materials in the device are substantially zero in the direction thereby improving device yield, performance, and reliability;

a first selected point on the centrally rounded bottom of said device material region having a first non-zero radius of curvature while a second selected point on the centrally rounded bottom of said device material region having a second non-zero radius of curvature;

said first and second radii of curvature differing from each other in a way selected from the group consisting of: a) significantly; b) differing by over several times; 3) differing by over one order of magnitude; and 4) differing by over two orders of magnitude; and

said first and second selected points being both vertically and laterally within one micron of each other.

74. (Currently Amended) A mass-produced, solid state integrated circuit device as in claim 57 in which the rectifying barrier region has a curved peripheral surface to achieve enhanced device reliability; increase yield; decreased cost; improved junction surface passivation; increased packing density; increased switching speed; reduced noise, instability, leakage current and electrical shorts; improved breakdown voltage; controlled carriers generation, movement, and recombination at or near the junction region peripheral surface; and regulated optoelectromagnetic interaction of the rectifying barrier region with ambient or contacting material.

75. (Canceled)

76. (Currently Amended) A commercially mass-produced IC of Claim 1, in which a selected surface of one of ~~on~~ said solid substrate, said solid material pocket, and said rectifying barrier contacts a non-flat surface ~~on~~ at a number of the rest of said solid substrate, said solid material pocket, and said

rectifying barrier; said number being one or two.

77. (Currently Amended) A commercially mass-produced IC of claim 76 in which:

said selected surface is selected from the group consisting of a side surface, a top major surface, and a bottom major surface; and

has ~~having~~ a shape selected from the group consisting of:
(a) a round surface; (b) a major-portion rounded surface; and
(3) a surface rounded in its entirety.

78. (Currently Amended) A commercially mass-produced IC of claim 1 in which, on a vertical cross-section thereof, two selected points on at least a number of a top major surface of said solid substrate, a top and a bottom major surfaces of said solid material, pocket, a top and a bottom major surfaces of said rectifying barrier, and a bottom major surfaces of said solid state material region are at two different vertical levels;

said number being selected from the group consisting of one, two, three, four, five, and six; and

said two selected points being both vertically and laterally within one micron of each other .

79. (Currently Amended) A commercially mass-produced IC of claim 1 in which, on a vertical cross-section thereof, two selected points on at least a number of a top major surface of said solid substrate, a top and a bottom major surfaces of said solid material pocket, a top and a bottom major surfaces of said rectifying barrier, and a bottom major surfaces of said solid state material region are non-flat but curved in a way selected from the group consisting of: (a) a substantial portion thereof curved; (b) a major portion thereof curved; and (3) curved in

its entirety;

said two points being both vertically and laterally within one micron of each other.

80. (Currently Amended) A commercially mass-produced IC of claim 1 in which, on a vertical cross-section thereof, a specified portion on at least a number of a selected top and a selected bottom major surfaces of said solid substrate, a selected top and a selected bottom major surfaces of said solid material pocket, and a selected top and a selected bottom major surfaces of said rectifying barrier, and a selected top and a selected bottom major surfaces of said solid state material region are non-parallel to a number of said other selected surfaces except for a selected nearby contacting surface;

said number being selected from the group consisting of one, two, three, four, five, six, and seven; and

said selected surfaces being both vertically and laterally within one micron of each other or one another.

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81. (Currently Amended) A commercially mass-produced IC of claim 1 in which said solid substrate has a first top major surface and a second bottom major surface, and said electronic rectifying barrier has a third top major surface and a fourth bottom major surface;

at least one of said first, second, third, and fourth major surfaces being non-parallel to at least a number of said other three major surfaces;

said number being selected from the group consisting of one, two, and three;

at least selected portions of said first, second, third, and fourth major surfaces being all within two microns of each other or one another.

82. (Currently Amended) A commercially mass-produced IC of claim 1 in which said rectifying barrier directly contacting said solid state material region has one of the following shapes: a) at least a selected portion of the contacting rectifying barrier is non-flat; b) at least a selected portion of the contacting rectifying barrier is curved; c) at least a major portion of the contacting rectifying barrier is non-flat; d) at least a major portion of the contacting rectifying barrier is curved; e) said contacting rectifying barrier is non-flat in its entity; f) said contacting rectifying barrier is curved in its entity; g) said contacting rectifying barrier is non-flat substantially in its entity; and h) said rectifying barrier substantially is curved substantially in its entirety.

83. (Previously Presented) A commercially mass-produced IC of claim 1 in which, on a vertical cross-section thereof, selected respective portions of a top major surface of said solid substrate, a bottom major surface of said solid material pocket, and a top major surface of said rectifying barrier are all curved;

at least one of three selected curved portions has a first peripheral surface contacting, at a contact area, a second peripheral surface of another of the three selected curved portions;

said first peripheral surface being differentially surface-expanded at said contact area over an area selected from the group consisting of: (a) a specified portion thereof; (b) a major portion thereof; (c) the entirety thereof; and (d) substantially the entirety thereof.

84. (Currently Amended) A commercially mass-produced,

solid state, integrated circuit device IC of claim 57 in which said device material region comprises a cooling fluid.

85. (Previously Presented) An IC of Claim 1, wherein said solid state material region has a bottom located within a specified vertical distance from a selected point inside said rectifying barrier;

said specified distance being selected from the group consisting of: a) one micron; b) 0.1 microns; c) substantially zero; d) between 0 and 0.1 microns; and e) between 0 and 0.1 microns but closer to 0 microns than to 0.1 microns.